(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: 0 486 952 A2

(12) EUROPEAN PATENT APPLICATION

(21) Application number: 91119477.7

(51) Int. Cl.^{5}: C03B 29/08, C03B 23/023

(22) Date of filing: 14.11.91

(30) Priority: 19.11.90 FI 905695

(43) Date of publication of application:
27.05.92 Bulletin 92/22

(84) Designated Contracting States:
CH DE FR GB IT LI

(71) Applicant: TAMGLASS OY
Vehmaistenkatu 5
SF-33730 Tampere(FI)

(72) Inventor: Salonen, Tauno Tapio
Ylisenkatu 1 B 15
SF-33710 Tampere(FI)
Inventor: Yli-Vakkuri, Erkki Paavo Johannes
Helakallionkatu 34
SF-33580 Tampere(FI)

(74) Representative: Patentanwälte Grünecker, Kinkeldey, Stockmair & Partner
Maximilianstrasse 58
W-8000 München 22(DE)

(54) Heating apparatus for a glass-sheet bending station.

(57) The invention relates to a heating apparatus for a glass-sheet bending station, said apparatus comprising an array of elongated heating resistance elements (3), positioned side by side to develop a resistance field covering the area of a glass sheet (4) to be bent, as well as a control mechanism (1, 2) for switching resistance elements (3) on and off. Separate, independently controlled resistance elements (3) are placed in resistance element fields successive in the longitudinal direction of said resistance elements and control mechanism (1, 2) is adapted in accordance with a selected program to switch on resistances (3) of successive resistance element fields in such a stagger that the resistances switched on in successive fields produce at least one heating line whose direction is different from that of the resistance elements.

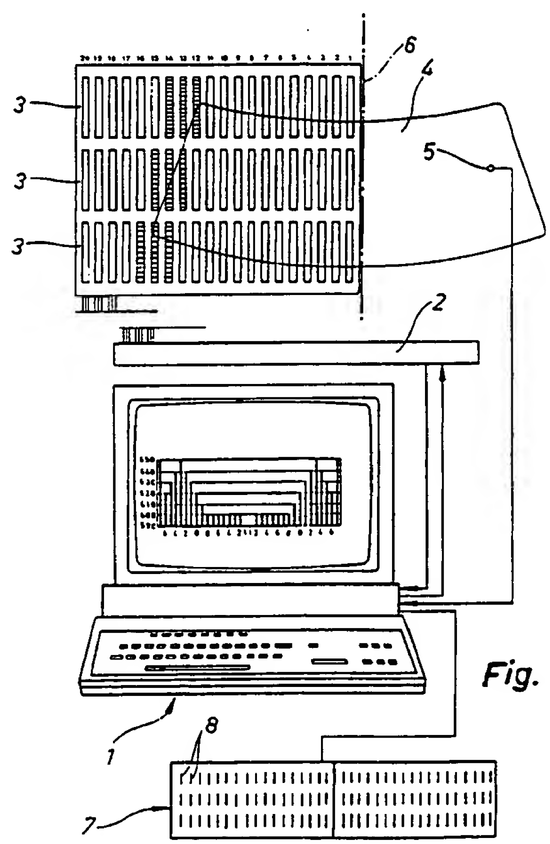

Fig. 1

EP 0 486 952 A2

The present invention relates to a heating apparatus for a glass-sheet bending station, said apparatus comprising an array of elongated heating resistance elements, positioned side by side to develop a resistance field covering the area of a glass sheet to be bent, as well as a control mechanism for switching the resistance elements on and off.

The Applicant's Patent publication US 4 497 645 discloses a bending furnace, including a bending station in which the present invention can be applied. However, the invention is applicable in all types of glass-sheet bending stations in which a glass sheet is heated by means of electrical resistance elements close to a softening temperature at which a glass sheet can be bent. There can also be more than one bending station, e.g. two or three in succession. In this case, the bending of a glass sheet is effected sequentially in successive bending stations.

When bending e.g. automotive windshields or backlights, it is necessary to localize or focus the heating effect on various sections of the glass in a manner that the glass sheet will be heated more in the areas of vigorous bending lines than in those areas which only require slight bending. Focusing the heat so as to achieve a controlled bending is problematic even in terms of just a single type of glass sheet to be bent. The situation will be particularly problematic when the locations and directions of bending lines also change along with the variations of types of glass sheets to be bent. Efforts have been made to resolve the problem by using maneuvarable and re-directable resistance elements (Patent publications EP 335 749 and US 4 726 832). However, mountting the maneuvering mechanisms in the hot interior of a bending station is a very invonvenient and expensive solution to carry out.

An object of the invention is to resolve the above problem by a novel arrangement and control of resistance elements in a manner that the heating pattern or the local focusing areas of heating can be controlled as desired in terms of their surface area, configuration and direction without maneuvering the resistances.

This object is achieved by means of the invention on the basis of the characterizing features set forth in the annexed claim 1.

The invention will now be described in more detail with reference made to the accompanying drawings, in which

fig. 1 shows a block diagram of the main components and operation control for an apparatus of the invention.

Figs. 2 - 5 illustrate various selections for switched-on resistance patterns with a varying surface are, number and direction (stagger) for individual heating lines.

All figures illustrate individual resistance elements 3 located on the left-hand side of the centre line 6 of a resistance element field. In the present cases, the number of resistance elements on one half-field is 3 x 20, i.e. 60 elements. In the longitudinal direction of resistance elements 3 there are three separate resistance elements that can be independently switched on and off. These build up three successive resistance element fields, whose individual resistance elements 3 can be switched on at such a stagger that the resistances switched on in successive fields provide a heating line having a direction different from that of resistance elements 3. The direction of a heating line, i.e. the degree of stagger of resistance elements, can be programmably controlled by employing the staggering of one or more adjacent resistances in successive fields. In addition to this possibility, it is naturally possible to use other types of switching configurations for resistances; e.g. all resistances can be switched on; resistances of the top and bottom fields can be switched on and the mid-field resistances off or vice versa; and solely the top or bottom field resistances are switched on and the rest off. The various switching configurations or patterns of resistances can be used at various stages of a heating and bending cycle. However, towards the final stage of bending, as a glass sheet begins to bend, it is particularly important that the heating be focused on the bending lines. On the other hand, in order to develop an edge stress in a glass sheet, it is necessary to apply a uniform heating effect to the edges of a bent glass sheet prior to the rapid cooling thereof. The staggering of resistance elements according to the invention also facilitates heating the edge of glass sheets of varying sizes and shapes for developing an edge stress.

The resistance element field is typically located on the ceiling of a bending station and a glass sheet 4 to be bent is brought underneath the resistance field supported on a ring mould. Naturally, the bending mould may also comprise a whole-surface mould or a combination of a ring mould and a partial-surface mould.

Switching said resistance elements 3 on and off is effected by means of a control mechanism, comprising a PC computer 1 and a block 2 which includes a switch or a contactor in a power supply circuit leading to each resistance 3 as well as logic circuits, controlling the switches or contactors and reading the ON/OFF states of individual resistances 3 and informing the process-controlling computer 1 of any given switching pattern of the resistance field.

In a glass bending operation, the temperature of glass 4 is being measured by means of one or more pyrometers 5. During a bending operation, the measuring pyrometer will be selected to be the one closest to the major bending point of glass. The obtained measurement reading is supplied to computer 1, wherein it is used as a reference reading for controlling all resistance elements 3. As temperature rises, the only switched-on resistance elements 3 will be those whose respective column extends on the display of computer 1 to above the corresponding temperature limit. Each successive field of resistance elements 3 is provided with its own set of columns (not necessarily shown on the screen), the staggering of the invention being achieved by shifting the position of the tallest columns within the set of columns of successive resistance fields.

A bending program for a certain type of glass can be set up in two ways.

1. A first glass can be bent manually by using a control panel 7, including a switch 8 separately numbered for each resistance for switching individual resistance elements 3 on and off. The completed operations are stored as the bending is finished (teach-in).
2. A bending program is set up by means of the CRT display and keyboard of computer 1 by making use of a graphical parameters input program.

In both cases, the finished programs are recorded in the hard-disc memory of computer 1 for reading them therefrom for operation, if necessary. The programs can be corrected if necessary either by means of a graphical set-up program or by re-effecting the bending under a manual control.

The control of resistance elements is accelerated and facilitated as they can be controlled as combined in various arrays. Such grouping or araying lines include:

1. The left- or right-hand side of a bending station
2. The forward, middle or rear section of a bending station
3. The staggering of heating resistance elements in 0, 1, 2 or 3 steps
4. The switching of heating resistance elements in groups or arrays.

These selections of groups or arrays are studied in more detail hereinafter.

1. Normally, when bending symmetrical glasses, a glass to be bent is placed in the middle of a bending station. In this case, the left- and right-hand side heating resistances 3 of a bending station can be controlled simultaneously. Thus, the group selection "left and right" is set active.
2. Depending on a type of glass to be bent, the group selection "forward, middle or rear section" can be used to provide more bending in the middle, top or bottom edge of a glass.
3. Fig. 2 shows an example, wherein the first array of resistance elements counted from the middle has a direct stepped selection, the fourth and fifth arrays of resistance elements have a direct stepped selection and a fixed selection 2, the eighth, ninth and tenth arrays of resistance elements have a direct stepped selection and a fixed selection 3 and the thirteenth array of resistance elements has a stepped selection 1 and a fixed selection 1. Fig. 3 shows a stepped selection 0, fig. 4 a stepped selection 2 and fig. 5 a stepped selection 3.
4. If heating resistance elements 3 are to be switched on or off in the lateral direction of a furnace in larger groups, a group or array can be selected to include two or three adjacent heating resistance elements instead of just one element.

Thus, when applying the invention, each type of glass to be bent is provided with its own resistance-control program which, on the basis of a temperature measured at the bending point, switches on, or more correctly, neglects to switch on a certain number of resistances, the heating lines formed thereby being in the right place and at a suitable stagger for this particular type of glass.

Claims

1. Heating apparatus for a glass-sheet bending station, said apparatus comprising an array of elongated heating resistance elements (3), positioned side by side to develop a resistance field covering the area of a glass sheet (4) to be bent, as well as a control mechanism (1, 2) for switching resistance elements (3) on and off, **characterized** in that separate, independently controlled resistance elements (3) are positioned in resistance element fields successive in the longitudinal direction of said resistance elements and a control mechanism (1, 2) is adapted in accordance with a selected program to switch on resistances (3) of the successive resistance element fields in such a stagger that the resistances switched on in successive fields produce at least one heating line extending in a direction other than that of the resistance elements.

2. An apparatus as set forth in claim 1, **characterized** in that the degree of stagger, i.e. the angle between said heating line and the longitudinal direction of resistances (3), is programmably adjustable by using in successive fields a shift of one or more adjacent resistances (3).

3. An apparatus as set forth in claim 1 or 2, **characterized** in that adjacent heating lines have a different degree of stagger.

4. An apparatus as set forth in any of claims 1 - 3, **characterized** in that adjacent heating lines include varying numbers of adjacent resistance elements (3).

5. An apparatus as set forth in any of claims 1 - 4, **characterized** in that the heating lines on the left- and right-hand side of the centre line of resistance element fields are located symmetrically and extend symmetrically relative to said centre line.

6. An apparatus as set forth in any of claims 1 - 5, **characterized** in that a pyrometer (5) is adapted to measure the temperature of glass (4) within the area of vigorous bending and the measured temperature serves in control mechanism (1, 2) as a reference reading for switching on a predetermined resistance pattern or for maintaining it switched-on depending on the measured temperature.

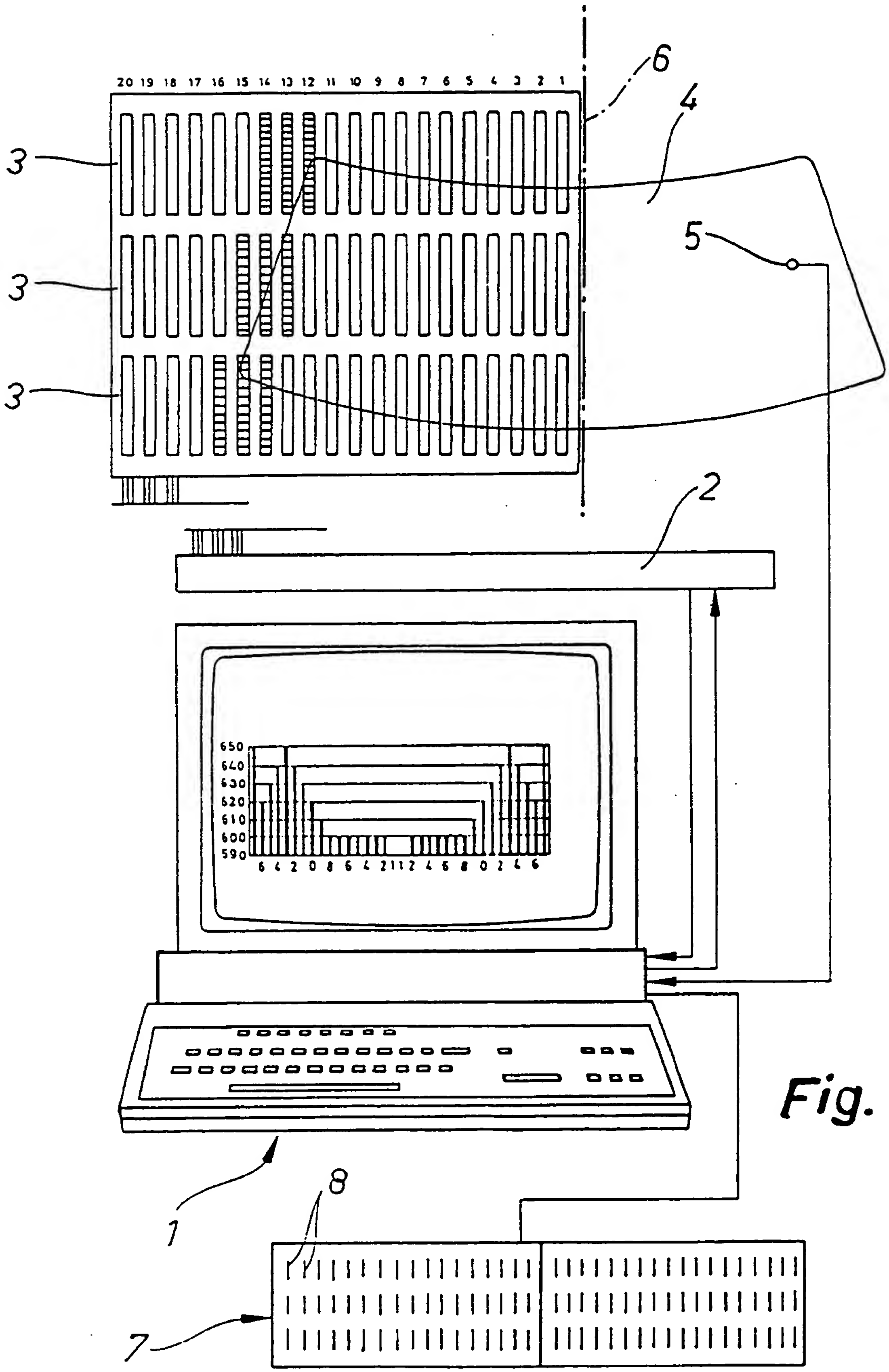
20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1
6
4
3
3
3
5
2
650
640
630
620
610
600
590
8
1
7

Fig. 1

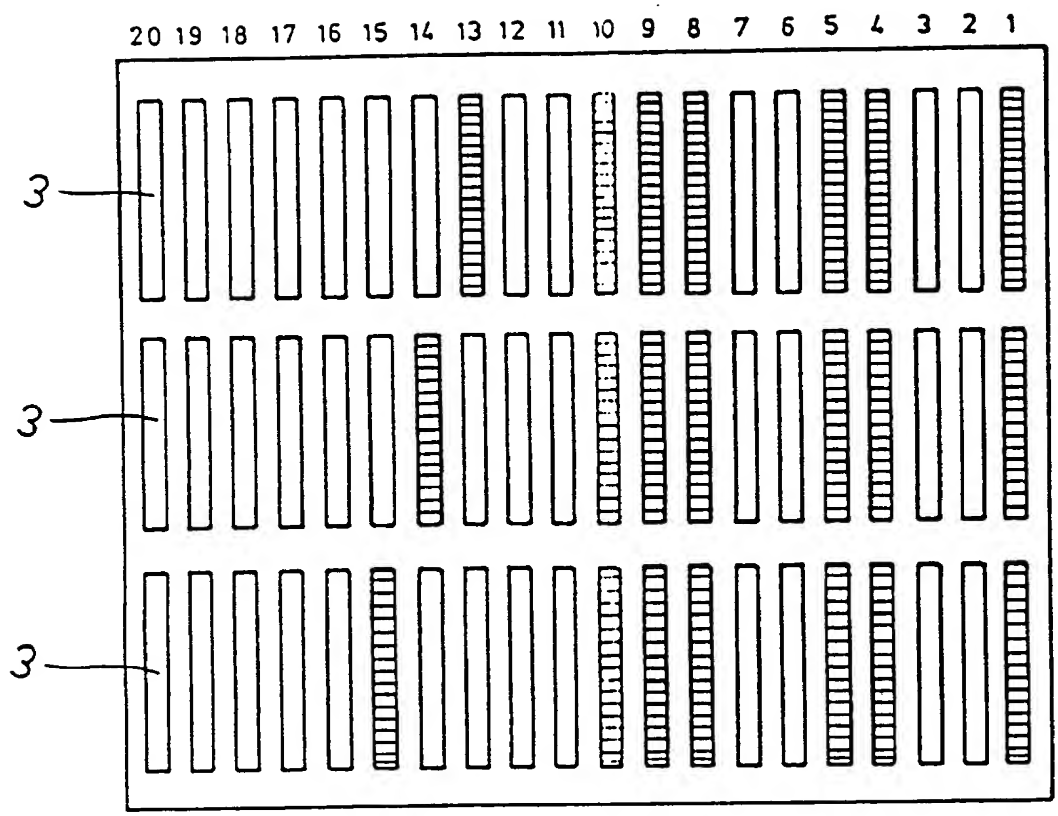

Fig. 2

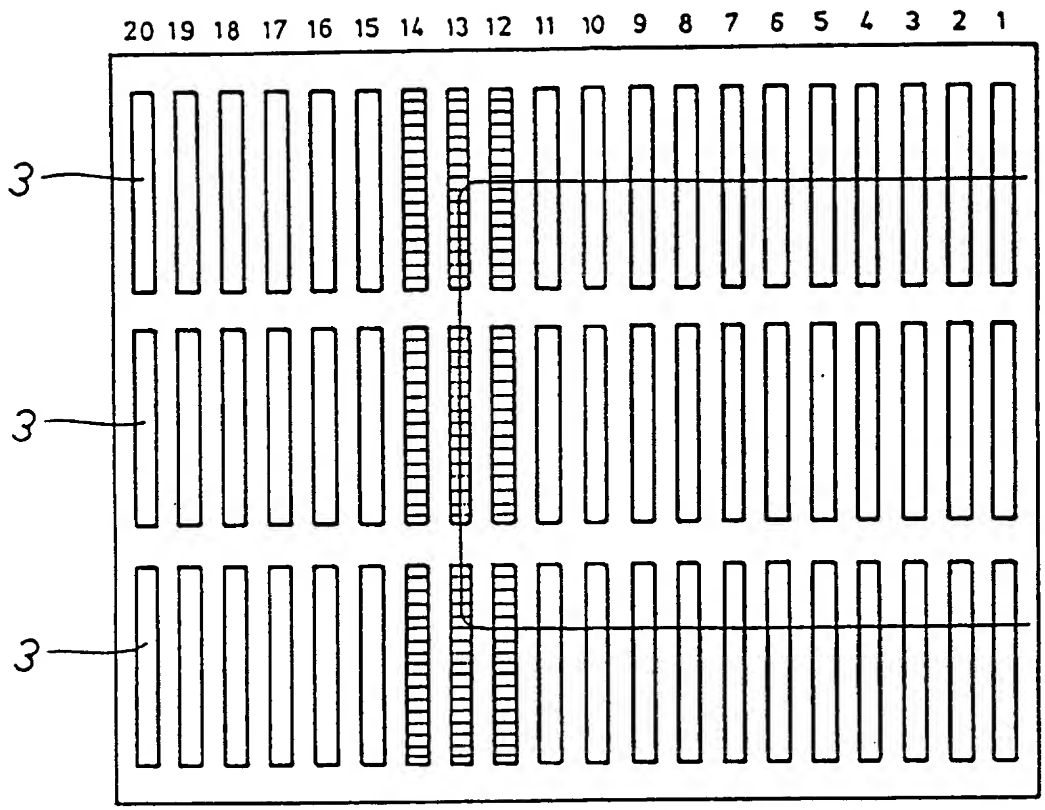

Fig. 3

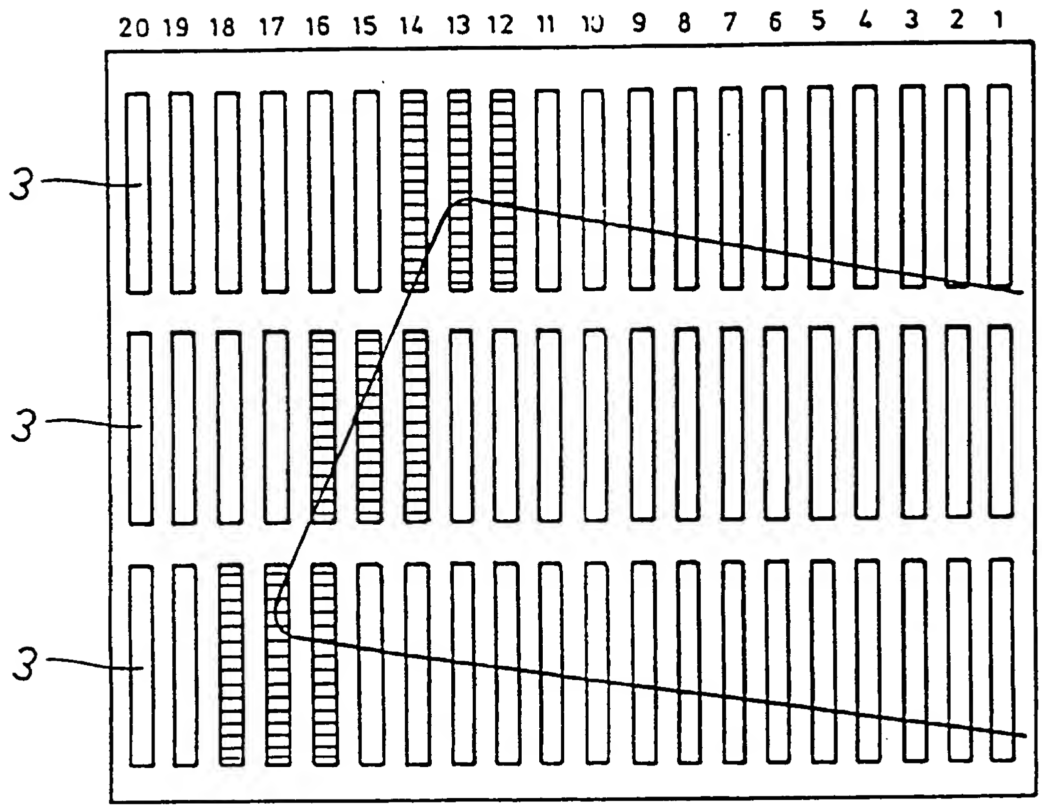

Fig. 4

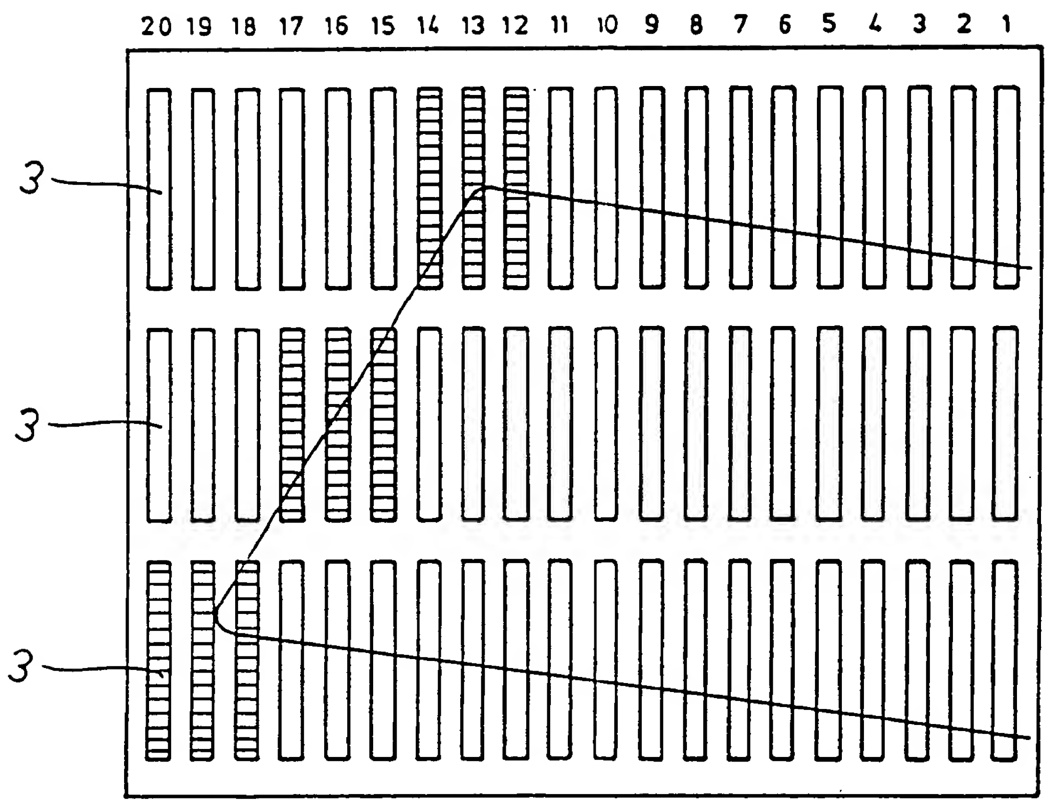

Fig. 5